



POSTAL BOOK PACKAGE 2026

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MECHANICAL ENGINEERING

Objective Practice Sets

Heat Transfer

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Introduction and Basic Concepts

MCQ and NAT Questions

- Q.1** Heat transmission is directly linked with the transport of medium itself, i.e., there is actual or bulk motion of heated particles during
- conduction only
 - convection only
 - radiation only
 - conduction as well as radiation
- Q.2** Choose the correct statement
- Thermal conductivity for metals decreases with increase in temperature
 - Thermal conductivity for gases and insulating material decreases with increase in temperature
 - Thermal conductivity is not a function of temperature
 - Thermal conductivity increases with increase in temperature irrespective of material
- Q.3** Arrange the following substance in increasing order of thermal conductivity.
- | | |
|-----------|--------------|
| 1. Copper | 2. Aluminium |
| 3. Water | 4. Air |
- Which one of the following sequence is correct?
- 4-3-2-1
 - 4-3-1-2
 - 3-4-2-1
 - 3-4-1-2
- Q.4** The inner surface of a plane brick wall is at 50°C and the outer surface is at 25°C. The rate of heat transfer per m² of the surface area of the wall, which is 220 mm thick is (the thermal conductivity of the bricks is 0.51 W/m K).
- 20.65 W/m²
 - 32.75 W/m²
 - 47.62 W/m²
 - 57.95 W/m²
- Q.5** All the three modes of heat transmission are involved in
- melting of ice
 - cooling of a small metal casting in a quenching bath
 - heat flow through the walls of a refrigerator
 - automobile engine equipped with a thermo-syphon cooling system
- Q.6** For a composite wall made of three layers, of three layers, *A*, *B* and *C* of different material wall thickness and temperature difference across the wall faces of layer *A*, *B* and *C* are 20cm and 100°C, 15cm and 180°C, 25cm and 100°C respectively. Which one of the following is correct? (assume area of each layer is same).
- Layer *A* has highest thermal conductivity (*k*)
 - Layer *B* has highest thermal conductivity (*k*)
 - Layer *C* has highest thermal conductivity (*k*)
 - All layers have equal thermal conductivity.
- Q.7** The heat conducted through a wall of thickness δ is given by
- $$Q = -kA \frac{dT}{dx} = -kA \left(\frac{T_2 - T_1}{\delta} \right)$$
- which amongst the following is not a correct statement?
- the term (δ/kA) is called thermal resistance
 - the term (kA/δ) is called thermal conductance
 - the factor (Q/A) is called thermal loading
 - the temperature gradient (dT/dx) is positive
- Q.8** Heat conduction in gases is due to
- electromagnetic waves
 - motion of electrons
 - mixing motion of the different layers of the gas
 - elastic impact of molecules
- Q.9** Thermal diffusivity is
- a dimensionless parameter
 - function of temperature
 - a physical property of the material
 - none of these
- Q.10** Your finger sticks to an ice tray just taken from the refrigerator, Which factor has more effect on this phenomenon?
- The inside temperature of the freezer (Suppose it's working properly)
 - The humidity of the air

- (c) The heat capacity of both your finger and the tray
(d) The thermal conductivity of the tray

Q.11 A cold liquid is stored in spherical vessel in order to

- (a) reduce rate of heat transfer
(b) increase rate of heat transfer
(c) prevent the liquid from freezing
(d) none of these

Q.12 Which one of the following is correct, in context of thermal diffusivity (α) of liquid and gas

- (a) $\alpha_{\text{gas}} > \alpha_{\text{liquid}}$
(b) $\alpha_{\text{gas}} < \alpha_{\text{liquid}}$
(c) $\alpha_{\text{gas}} = \alpha_{\text{liquid}}$
(d) Depend on other factors

Q.13 The unit of thermal diffusivity is

- (a) $\text{m}^2/\text{hr}^\circ\text{C}$ (b) $\text{kJ}/\text{m}^2\text{hr}$
(c) $\text{m}/\text{hr}^\circ\text{C}$ (d) m^2/hr

Q.14 The ratio of thermal conductivity to electrical conductivity is equal to

- (a) Prandtl number (b) Schmidt number
(c) Lorentz number (d) Lewis number

Q.15 Hot coffee in a cup is allowed to cool. Its cooling rate is measured and found to be greater than the value calculated by conduction, convection and radiation measurement. The difference is due to

- (a) properties of coffee changing with temperature
(b) currents of air flow in the room
(c) underestimation of emissivity of coffee
(d) evaporation

Q.16 The Fourier law of heat conduction is valid for

- (a) One dimensional only
(b) Two dimensional only
(c) Three dimensional only
(d) None of these

Q.17 Match the property with their units

Property	Units
A. Bulk modulus	1. W/s
B. Thermal conductivity	2. N/m^2
C. Heat transfer coefficient	3. N/m^3
D. Heat flow rate	4. W
	5. W/mK
	6. $\text{W}/\text{m}^2\text{K}$

Codes:

	A	B	C	D
(a)	1	2	6	5
(b)	2	5	6	4
(c)	2	6	4	1
(d)	1	5	3	2

Q.18 In a case of one dimensional heat conduction in a medium with constant properties, T is the temperature at position x , at time t . Then $\frac{\partial T}{\partial t}$ is proportional to

- (a) $\frac{T}{x}$ (b) $\frac{\partial T}{\partial x}$
(c) $\frac{\partial^2 T}{\partial x \partial t}$ (d) $\frac{\partial^2 T}{\partial x^2}$

Q.19 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

- A. Momentum transfer
B. Mass transfer
C. Heat transfer

List-II

1. Thermal diffusivity
2. Kinematic viscosity
3. Diffusion coefficient

Codes:

	A	B	C
(a)	2	3	1
(b)	1	3	2
(c)	3	2	1
(d)	1	2	

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Multiple Select Questions (MSQ)

Q.20 Which of the following statements is/are correct with respect to conduction heat transfer?

- (a) Heat transfer takes place by molecular lattice vibrational energy and due to free electron transfer in solids.
(b) If all other factors remains same (i.e. area, temperature gradients same), then conduction heat transfer by brass will be more than copper.
(c) All electrically good conductor are in general good conductors of heat also.
(d) Diamond is having the highest thermal conductivity among all known materials.

Q.21 Which of the following statements is/are correct?

- (a) Thermal conductivity is a thermophysical property of a material.
- (b) Heat conduction occurs in gases by molecular momentum transfer.
- (c) With increase in temperature thermal conductivity of gases decreases.
- (d) Liquids are better conductors of heat than gases.

Q.22 Which of the following statements is/are correct about a black body?

- (a) A black body is considered as an ideal emitter.
- (b) A black body is considered as a perfect absorber.

- (c) A black body is considered as non-diffusive in nature.
- (d) Snow and Ice are also considered as black body.

Q.23 Which of the following statements is/are correct?

- (a) In free convection heat transfer the motion of the fluid occurs naturally due to buoyancy forces.
- (b) Radiation heat transfer does not require any material medium for its propagation.
- (c) All bodies at all temperature emit thermal radiation except the body at 0 K.
- (d) Radiation heat transfer dominates over conduction and convection when the temperature difference is sufficiently large.

■■■■

Answers Introduction and Basic Concepts

1. (b) 2. (a) 3. (a) 4. (d) 5. (d) 6. (c) 7. (d) 8. (d)
 9. (c) 10. (d) 11. (a) 12. (a) 13. (d) 14. (c) 15. (d) 16. (a)
 17. (b) 18. (d) 19. (a) 20. (a, c, d) 21. (a, b, d) 22. (a, b, d) 23. (a, b, c, d)

Explanations Introduction and Basic Concepts

1. (b)

Actual movement of particles of the medium is present in convection only.

2. (a)

For gases thermal conductivity increases with increase in temperature and decrease with increase in molecular weight.

3. (a)

Substance	$k(\text{W/m-K})$
Copper	386
Aluminium	175.6
Water	0.51
Air	0.022

4. (d)

$$q = k \frac{\Delta T}{\Delta x} = \frac{0.51 \times 25}{0.22} = 57.95 \text{ W/m}^2$$

5. (d)

In syphon cooling system all modes conduction, convection and radiation takes place. Since it has high temperatures therefore radiation heat transfer

is also significant.

6. (c)

$$\therefore Q = \frac{k_1 A_1 \Delta t_1}{L_1} = \frac{k_2 A_2 \Delta t_2}{L_2} = \frac{k_3 A_3 \Delta t_3}{L_3}$$

$$\therefore A_1 = A_2 = A_3 = A$$

$$\therefore Q = \frac{k_1 \cdot \Delta t_1}{L_1} = \frac{k_2 \cdot \Delta t_2}{L_2} = \frac{k_3 \cdot \Delta t_3}{L_3}$$

$$\therefore Q = \frac{k_1(100)}{20} = \frac{k_2(180)}{15} = \frac{k_3(100)}{25}$$

$$\therefore 5k_1 = 12k_2 = 4k_3$$

$$\therefore k_3 > k_1 > k_2$$

7. (d)

$\frac{\delta}{kA}$ in thermal resistance

$\frac{Q}{A}$ in thermal loading

$\frac{dT}{dx}$ is negative in the direction of heat flow

8. (d)

Heat conduction in gases is due to collision of gases molecules. It is due to its elastic impact of molecules.

10. (d)

Due to high temperature difference between your finger and the tray, some heat will be transferred to the tray, depending on its capacity for thermal conductivity.

Since the surface of your skin is naturally moisturized (it's not a function of the air humidity), the loss of heat will cause a thin layer of ice to form on the skin which in turn sticks to the tray. No matter how dry is the air and how cold is the freezer, your finger will not stick to a wooden tray whose thermal conductivity is low. So the most important factor is the thermal conductivity of the tray.

11. (a)

Spherical vessel to reduce heat transfer as it offers the maximum thermal resistance.

12. (a)

Since thermal diffusivity, $\alpha = \frac{k}{\rho C}$

$$\begin{aligned} (\rho C)_{\text{liquid}} &> (\rho C)_{\text{gas}} \\ (\alpha)_{\text{gas}} &> (\alpha)_{\text{liquid}} \end{aligned}$$

13. (d)

Thermal diffusivity, $\alpha = \frac{k}{\rho C}$

Hence its unit = m²/hr or m²/sec

Note that unit of thermal diffusivity and kinematic viscosity is same.

14. (c)

The ratio of thermal conductivity to electrical conductivity is always constant for all the conductors at the given temperature. This is known as Wideman and Frange law.

$$\text{i.e. } \frac{k}{\sigma T} = \text{constant}$$

The constant is known as Lorentz number (Lo) whose value is equal to $2.045 \times 10^{-8} \text{ W}/\mu\text{K}^2$.

15. (d)

Some heat is also lost in evaporation. The vapours of water is not accounted in these 3 modes of heat transfer.

16. (a)

While deriving Fourier law of heat conduction some assumptions are made, which are

1. Steady state condition
2. One-directional heat transfer
3. No heat generation
4. Material is homogeneous and isotropic

18. (d)

The equation of heat transfer in Cartesian coordinates without heat generation is

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial z^2} = \frac{\rho C_p}{k} \frac{\partial T}{\partial t}$$

For one dimensional heat transfer,

$$\frac{\partial^2 T}{\partial x^2} = \frac{\rho C_p}{k} \frac{\partial T}{\partial t}$$

$$\text{i.e., } \frac{\partial T}{\partial t} \propto \frac{\partial^2 T}{\partial x^2}$$

19. (a)

Momentum transfer — Kinematic viscosity

Kinematic viscosity: $\nu = \frac{\mu}{\rho}$

Mass transfer — diffusion coefficient

Molecular diffusion is governed by Fick's law

$$N_A = \frac{m_A}{A} = -D_{AB} \frac{dc_A}{dx}$$

where, N_A = mass flux of species A

D_{AB} = diffusion coefficient

$$\frac{dc_A}{dx} = \text{concentration of gradient for species A.}$$

Heat transfer — Thermal diffusivity

Thermal diffusivity: $\alpha = \frac{k}{\rho C_p}$

20. (a, c, d)

1. 30% of conduction heat transfer takes place by molecular lattice vibrational energy transfer and 70% of conduction heat transfer takes place by free electron transfer in solids.